The fourth zone, covering Burlington County, is 16.2 miles long, with receivers on eight of eleven cell sites. This zone is also suburban in nature. Its length and placement of receivers negatively affected results.

b. Initial Results

OETS observed that the system performance underwent a significant improvement over time as the development team successfully identified and resolved various integration and scaling issues raised by this first large scale, wide area test of wireless location technology. This is a tribute to the Herculean effort and dedication of the TruePosition development team.

Organized testing began before the live trial was launched at the beginning of January, 1997. Initial results showed an average aggregate error of over 1,400 feet. A variety of software and hardware changes in the system during the live trial significantly improved the results as demonstrated in the following chart. The daily average error moved consistently downward until it was close to the FCC requirement a few days before the end of the first 100 days.

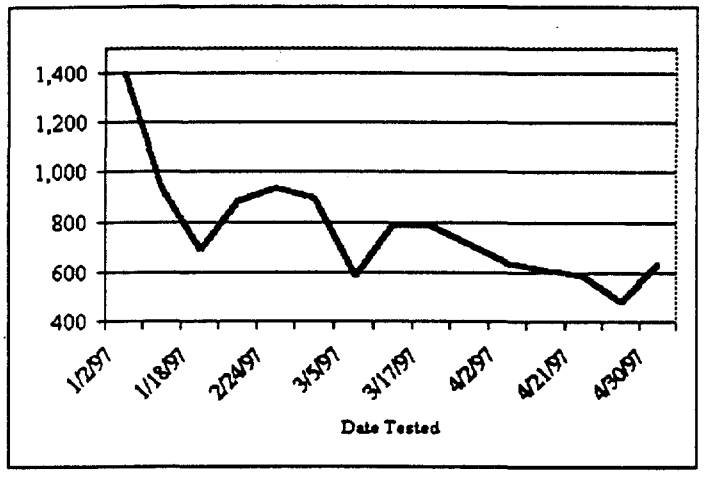


Figure 14 – Improvement of Location System Over Time (Error In Feet)

c. April Results

OETS has extensively analyzed the test data from the trial system, and concludes that technology exists to meet and exceed the 410 foot, 67% FCC Report and Order requirement. The analysis concludes that a permanently deployed, fully operational system should have a higher coverage ratio of location receivers to cell sites than the 55% used in the test.

Zone 3 had the best performance for all test points on all days in April, with 56% of all test calls within 410 feet. The overall system produced an average error of 635 feet.

OETS further analyzed the location system estimates to determine the portion of the error of the estimates that occurred parallel to the New Jersey Turnpike and the portion of the error that occurred transverse (or 90 degrees) to the Turnpike. This purpose of this analysis was to determine the effects that trial system coverage and the placement of receivers had on the results. The trial system was deployed as a long, narrow

system that was 50 miles long and only 7 miles wide. As discussed earlier, the overall coverage of the trial system was 55% (24 location sites / 43 cell sites), but when the coverage is examined in two dimensions (parallel to the highways and perpendicular to them, or roughly in the x- and y-dimensions), the coverage was better in the parallel dimension than in the transverse direction.

The overall performance (67% point) for all tests at all test points during April from all test participants was:

Zone	Aggregate Error	Parallel Error	Transverse Error
1	515	355	433
2	875	555	470
3	478	324	305
4	894	501	636

Note that zone 2 was heavily influenced by the results of a single test point in the data set. All data have been included for the sake of completeness. If the single test point from zone 2 (which occurred in a particularly poor coverage area of the both the cellular system and the location system) is removed and the remaining data is processed, the results would be:

Zone	Aggregate Error	Parallel Error	Transverse Error
1	515	355	433
2	695	409	486
3	478	324	305
4	894	501	636

As the above data show, results from measurements parallel to the two major highways were more accurate than transverse results for three zones, and approximately the same for zone 3 (which had the best system design), and in at least two zones exceeded the FCC Phase II requirement. This finding is of great practical value when locating vehicles on highways in rural areas is the most important need.

4. Problem Areas

The TruePosition system performance over the entire length of the New Jersey Turnpike test area was carefully monitored throughout the test. Early testing was mostly performed by the TruePosition development team to identify and isolate the performance of each element of the system. It became clear during the trial that further significant improvements in accuracy could only be made by "taking down" the system for a period of time to re-engineer and better implement certain aspects of the system. In other words, the live portion of the trial allowing real wireless emergency calls to be located would have been interrupted for a period of several days or longer. OETS made the decision to continue the live trial.

a. Coverage Factors Affecting Accuracy

By the end of the initial test period, it was clear that the system coverage as designed was too light. The TruePosition TDOA location technology rests on the complex application of simple geometrical principles. Its accuracy improves as the number of receivers with distinctly different perspectives to the wireless telephone increases, with best results achieved when the telephone is "surrounded" by at least four receivers relatively equally spaced around compass points.

If a telephone transmits on a direct line between two receivers, the system can relatively accurately position it on the straight-line dimension between those two, while producing much greater errors in transverse and therefore aggregate measurements. The relatively large number of receivers which were almost directly on the parallel of the New Jersey Turnpike and I-295 show why the parallel results noted above were far more accurate than the transverse or aggregate measurements.

From the drive testing data collected by PSAPs and various commercial trial participants for the month of April, it is clear that in certain locations accuracy was much better than in others. At specific points, latitude/longitude results were much better than the FCC's Phase II location requirements of 410 feet, 67%. In particular, several testing points in Zone 3 performed much better than the FCC Phase II requirements, and as a whole, Zone 3 produced the most accurate location results.

For the most part, the accuracy of the location technology throughout the trial depended on four interrelated factors. Taken alone, the data did not show an exact one-to-one correlation between each accuracy factor and each result. But taken as a whole, when these factors were satisfied by the system's engineering, the results were extremely accurate.

Of course, these factors were known before the test began, but the field test was critical because location technology had never before been tested on this scale. By actually testing these theories in the field, OETS and TruePosition partners believe that this trial provides extremely helpful data for performing future system designs to achieve optimal results.

(1) Density -- Build-out of wireless sites. The TDOA wireless location technology was not located on every Comcast Cellular Communications cell site (only 24 out of 43 total). Deploying at a larger number of cell sites would help to locate callers more accurately. As the table below shows, location technology was deployed most heavily, by sheer number of sites per mile, in Zone 3 (8 location receivers over 10 miles). Zone 3, as a whole, came closest to reaching the FCC's accuracy requirements.

(2) Placement -- Geometric Dilution of Precision (GDOP). The data indicates that the geometric placement of location technology receivers on various cell sites also played a significant role. GDOP is a measure that describes the degree to which a caller's location is properly surrounded by TDOA equipped cell sites -- at distances where signal strength is sufficient to be measured. The perspectives produced by an optimal number of at least four sites help to produce a more accurate report location. In the trial, lower GDOP measurements generally correlated to more accurate caller location estimates. Utilizing a particular type of software for this trial, a perfect GDOP rating was generally considered to be about 0.5. Zone 3 had the lowest aggregate GDOP rating at 0.8, while Zone 2 had the highest GDOP rating of 1.1.

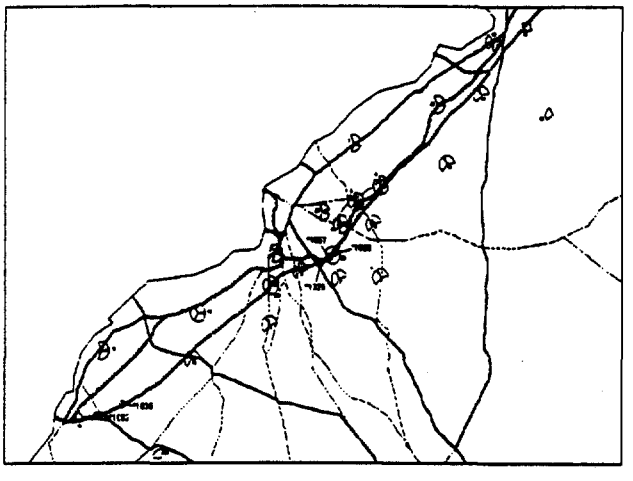
(3) Distance -- Length of Interstate Covered in Each Zone. While Zone 4 had the highest percentage of cell sites equipped with location technology (72%), it did not produce the most

accurate results. Signal strength from transmitters was also a factor in obtaining accurate location reports. While TDOA technology was deployed on 8 of 11 cell sites in Zone 4, the sites needed to cover a longer stretch of highway -- approximately 16.2 miles long -- compared to 10.6 miles for Zone 3. Greater distances often meant weak signals or no signal at all being received at distant sites.

(4) Interference -- Multipath, RF Emissions. In general, the wireless location technology used in the trial overcame significant RF emission interference. Despite high levels of RF interference in Zone 3 due to reflections from buildings and other causes, the system was still very effective. In general, multipath RF was a minor factor in lowering accuracy of location estimates. TruePosition's prior testing in the downtown areas of major cities had worked out most of these issues.

Zone	Density of TDOA Equipped Sites	Placement (Avg. GDOP)	Distance (Miles of Turnpike)	TDOA Sites Per Mile
1	67% (6 Sites/4 Equipped)	1.0	10.8	.37
2	50% (8 Sites/4 Equipped)	1.1	8.1	.49
3	44% (18 Sites/8 Equipped)	0.8	10.6	.75
4	73% (11 Sites/8 Equipped)	0.9	16.2	.49

The test points 1026, 1027, 1028 in Zone 3 for the month of April provide evidence of these factors at work. Each of these test points (see map below) is located between a number of TDOA equipped cell sites which are very dense throughout Zone 3. Each point is surrounded by a number of receivers to transmit a signal to -- translating into a low GDOP of 0.7 for all three locations. And because each is located nearby a cell site (short distance), the signal strength is strong. RF interference did not seem to be a problem either. The result: test point 1026 was located within 387 feet 67% of the time; 1027, 379 feet; and 1028, 336 feet.



Test Figure 15 – Example Points

Zone 1 provides another instructive example of the importance of proper coverage. As shown on the map, Zone 1 coverage had 4 receivers in a diamond configuration. Test point 2 at the southern end of the Turnpike showed a typical error of 800 feet, 67%. It was getting little to no "help" because no cellular antennae to the south, west or north were equipped with receivers. Only the receivers to the NNE and ESE were "helping". By contrast, the results in the middle of Zone 1, at test point 5 (at about the perpendicular intersection of lines connecting the four cell sites covering that Zone, consistently produced accuracy within 309 feet, 67%.

b. Variability -- The issue of calibration

Errors were not consistent over longer times (several days), but measurements were consistent within shorter time frames. Despite the coverage issues noted above, many test sites produced measurements within the FCC Phase II requirement on a regular basis, but then produced significantly larger errors on other days. An example of the day to day variability is shown below:

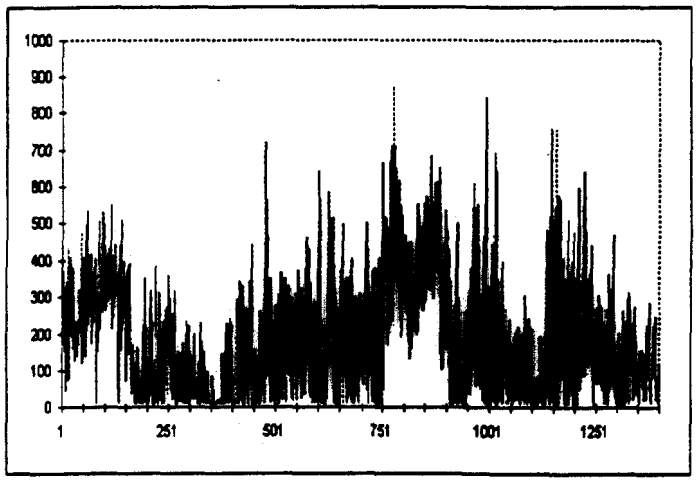


Figure 16 – Example of Day to Day Variability (Error in Feet)

The chart depicts the calculated location of a test phone at a fixed place, where the test phone placed a call approximately every 10 minutes. In this chart, 1,400 consecutive test calls are represented over a multi-day period. The test call sequence number is represented on the horizontal axis, and the accuracy of the calculated location is represented on the vertical axis. As seen in this one example, the accuracy varies, but generally remains below 410 feet through the first 750 test calls over several days. The accuracy then encounters periods of increased variability, then reduced variability.

The day to day variability of the location system was isolated by the TruePosition development team to the technique chosen for time synchronizing the 24 location receivers. This particular technique, known as external calibration, was successfully used in smaller system tests last year, but had never been attempted before in such a large location system deployment, and could not have been attempted without a trial of this scale (50 miles of highway, 350 square miles total).

In a TDOA system, the various receivers within the system must be kept constantly synchronized to within 30 nanoseconds of each other (30 billionths of a second). For various technical reasons, the particular calibration technique chosen proved to be difficult to stabilize over longer periods (many days) of time. The

TruePosition team identified this issue within the first 30 days of the trial, and made all possible software changes to increase the stability as much as possible. Ultimately, however, it was decided that this particular calibration technique was not appropriate for large location systems, and that a different technique should be used. Changing synchronization techniques would have required hardware changes to the TruePosition system, which were not acceptable during the trial period, because it would have meant an interruption in the delivery of the live Phase II wireless enhanced 9-1-1 service of several days.

In the chart of the fixed phone over several days, this synchronization issue can be observed in the drift of the average error. One observable effect of this external calibration issue was that successive location calculations at a particular test point would cluster very well, but that all of the location estimates would be biased to one side or another. The clustering meant that the location system had a very repeatable performance, which is an excellent measure of the success of the technology. The bias was an effect of the calibration technique chosen and therefore could be eliminated by choosing a better synchronization technique. By itself, this bias generally represented between 25-40% of the location measurement error. TruePosition believes it has developed a solution, but as noted, this was not implemented during the test.

VI. Conclusion For The First 100 Days

OETS has drawn the following summary conclusions from the first 100 days of the first live wireless E9-1-1 trial in the United States:

- **Wireless 9-1-1 Call Volume Is Growing**

With the changes made to the 9-1-1 network for this wireless trial, OETS obtained statistics about both wireless and wireline 9-1-1 call volume. On some days, wireless 9-1-1 call volume approached the volume of wireline 9-1-1 calls. This includes calls that came from within the Phase I and Phase II trial areas, as well as calls from other places in the counties that were not included in the trial area.

- **TDOA Location System Solves the Operational Challenges of Wireless 9-1-1 Growth**

The TDOA system solved the operational challenges PSAP telecommunicators are having with the explosion of wireless 9-1-1 calls by providing accurate location data. No live calls produced complaints from public safety telecommunicators concerning incorrect locations. On most occasions during the trial, functionally correct locations of 9-1-1 callers were displayed on PSAP terminals before the dispatcher even heard the caller's voice. From a PSAP operations perspective, the test was a major success.

- **Location Technology Is Available**

While OETS is not endorsing any one technology, the TruePosition system demonstrated its ability to locate wireless 9-1-1 callers within the FCC requirement of 410 feet, 67%. Its receivers need to be on a higher percentage of cell sites, and it must refine its calibration system. There may well be other effective technology which has yet to be tested.

- **Development Issues Were Minor And Can Be Overcome**

No aspect of the trial system was fully complete from a development perspective, but the issues encountered were minor and can be overcome. It is a small step from this trial system, deployed only 6 months after the FCC issued its Report and Order, to fully operational wireless enhanced 9-1-1 systems across the country.

o **9-1-1 Network Impacts Are Manageable**

The changes required to the existing 9-1-1 network and to the PSAPs were easily manageable during the trial, and are forecast to remain so even during a full statewide deployment. Bell Atlantic-New Jersey reported no concerns with the 9-1-1 tandems during the trial.

o **Issue Now Shifts To The Business Side**

As this trial continues to successfully demonstrate wireless enhanced 9-1-1 technology, the deployment issues really shift from technologic feasibility to resolving the business issues between the wireless carrier community and their customers. OETS will encourage all wireless carriers in New Jersey to join in discussions to accelerate implementation. For example, OETS is prepared to universally implement Phase I systems across the State within the next six months.

o **FCC Clarifications Would Resolve Any Vagueness During Carrier Discussions**

As the first to implement live wireless enhanced 9-1-1, OETS encountered issues in the Report and Order that could be helped with some clarification from the FCC. These are detailed below.

o **Vendors Are Asked To Continue The Trial**

Due to the success of the trial, and the benefits received by both the citizens of New Jersey and the 9-1-1 PSAPs of Salem, Gloucester, and Camden counties, OETS has urged the vendors involved to continue the trial. Several of the wireless trial participants would like an opportunity to make further improvements now that the initial trial period is completed. All of the participants are interested in continuing the trial.

VII. Clarifications to the FCC Report and Order

Based upon its experience with planning, implementing, and testing during this first wireless enhanced 9-1-1 trial, OETS would like to suggest the following clarifications to the FCC Report and Order. This clarification would likely aid other 9-1-1 agencies and carriers nationwide in implementing wireless enhanced 9-1-1 systems.

A. Measurement of the location system accuracy should be the 67% point

The FCC Report and Order in Docket 94-102 discusses the measurement of location accuracy in various terms. The dominant discussion in the Order and certainly in public has been the 67% accuracy point. The 67% point of a data set of location measurements is calculated by ordering the location measurements from smallest value to largest value, and then identifying the value, or point, at which 67% of the measurements are smaller than the identified point, and 33% of the measurements are larger than the identified point.

The Root Mean Square (RMS) of the data set is also mentioned in the report, however, which has created some confusion. The RMS measure of accuracy is calculated using a separate process whereby the value of each of the location errors is squared, then all of the squared values are summed together, then the sum is divided by the number of location measurements in the set, and lastly, the square-root of the result is calculated. During the location trial, many data sets were analyzed, and both the 67% point and the RMS value of the data set were determined. The values are rarely the same, and the RMS value can be greater than or less than the value the 67%

point. Therefore, there is no one true measure of the statistics of a data set. Rather, one method should be chosen and implemented universally for the sake of consistency.

The recommended method for measuring the statistics of a location measurement data set is the 67% point measurement. It is a simpler method and is consistent with the recommendations of the NENA Technical Subcommittee last year during the proceedings of Docket 94-102 that a measure be chosen that yields a known, consistent percentage of calls within the chosen accuracy.

B. Wireless 9-1-1 calls should be routed by caller's location in Phase II systems

The wireless E9-1-1 trial in New Jersey routed calls by caller's location when the caller was in the Phase II coverage area of the system. Otherwise, the call was routed by cell site location. The test area was covered by four regional county PSAPs with large and clearly identified service areas. However, even with these large service areas, calls routed by cell site location (i.e. Phase I methodology) were inappropriately routed approximately 30% of the time. In other areas of New Jersey where cell sites cover several jurisdictions, inappropriate routing approaches 100%. The Report and Order does not explicitly address this change in routing methodology from Phase I to Phase II, but OETS recommends this clarification because of the benefits obtained from not only calculating the caller's location, but also routing the call based upon that location.

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